GAS DECARBONISATION AND SECTOR COUPLING

Ensuring a market-based approach: a report for the European Federation of Energy Traders

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EXECUTIVE SUMMARY

Unabated natural gas likely has a limited long-term role in a decarbonised EU energy system. However, renewable and other low-carbon gases can contribute to resolving challenges regarding the transportation and storage of energy that are likely to become increasingly relevant in the transition towards a carbon-neutral economy.

Working for the European Federation of Energy Traders (EFET), Frontier Economics ('Frontier') has evaluated different future market design options which reward carbon abatement (or alternatively penalise non-abatement) in the gas sector in a market-based, technology-neutral way.[1] We have also considered a framework to ensure that flexibility available in the gas system is used efficiently, to support an electricity system marked by an increasing share of intermittent renewable power production. This is often seen as an important element of "sector coupling", an increased interaction between the electricity, gas and possibly other fuel sectors.

This report is structured as follows:

- Section 1 sets out the future role of the gas system, as background;
- Section 2 analyses the current policy landscape for gas decarbonisation and sector coupling, and considers the implications for the energy transition if the framework is left unchanged;
- Section 3 evaluates the potential options for reforming the climate policy framework to support gas decarbonisation; and
- Section 4 sets out our recommendations for policymakers in further detail.

The box overleaf contains a summary of our recommendations.

[1] This study focuses on market-based solutions to decarbonise the gas sector. Elements of the proposed solutions could also apply to liquid hydrocarbon fuels which play an important role in the transport sector. Given the current climate policy framework for transport consists of a distinct set of instruments (such as fleet emissions targets), this different starting point would, however, need to be taken into consideration for any future intervention covering the transport sector. This is out of the scope of this study.

KEY RECOMMENDATIONS FOR POLICYMAKERS

- Set clear overall decarbonisation targets for the whole economy. Be clear on the benefits (and limitations) of markets and incentives.
- Define a credible harmonised EU-wide carbon pricing scheme as the long term driver for decarbonisation across the economy. This regime could be anchored in the EU Emissions Trading System (ETS), with an expansion of the ETS to buildings and transport (including maritime) being a key step on the way. Provide Member States with tools to mitigate any associated distributional impacts.
- Set a pathway for greater harmonisation between any national carbon pricing schemes (for prospective gas sector regimes, but also existing electricity sector regimes) and for their eventual merging with an EU-wide scheme.
- Alongside carbon pricing, accept market-based support mechanisms for low-carbon gas production in the interim (particularly while technology costs are still falling quickly). Such mechanisms should be technology-neutral, avoid handing producers or suppliers fixed, non-market based subsidies, and be open across EU (and third country) borders. Plan for these also to be capable of covering electricity production, and for an eventual exit from support once carbon pricing is well developed across sectors.
- In order to ensure that any interim support mechanisms do not undermine ETS pricing, adjust the trajectory of ETS allowances provided to the market, to take account of abatement achieved through interim support mechanisms.
- To underpin both carbon pricing and any market-based support mechanisms, develop a scheme to certify the relative greenhouse gas content of gases on a consistent basis (ideally based on existing EU instruments such as guarantees of origin or sustainability certificates).
- Avoid regulated company involvement in installations such as power-to-gas conversion plants, which could be developed through competitive arrangements, unless there is a clear justification (e.g. rooted in a market failure logic) that cannot be feasibly addressed through other means (for example through reforms to market design).
- Develop regulatory and institutional measures, including cross-sector cost-benefit analyses, which ensure network infrastructure development is optimised across electricity and gas at national and EU levels.
- Ensure market participants face signals (including in the form of connection charges, grid tariffs, congestion pricing, ancillary service revenues and/ or imbalance charges), which reflect the network and system balancing impacts their investment and operational choices will cause (whether positive or negative) across the whole energy system (gas and electricity). Avoid tariff and levy charging structures, as well as taxes and tax breaks, which distort market participants' choices.
- Promote research and development in low-carbon gas technologies.

1 THE GAS SYSTEM HAS A LONG-TERM ROLE TO PLAY IN A DECARBONISED ENERGY SECTOR

In this section, we set out the potential role of renewable and other low-carbon gas(es) in a decarbonised EU energy system.

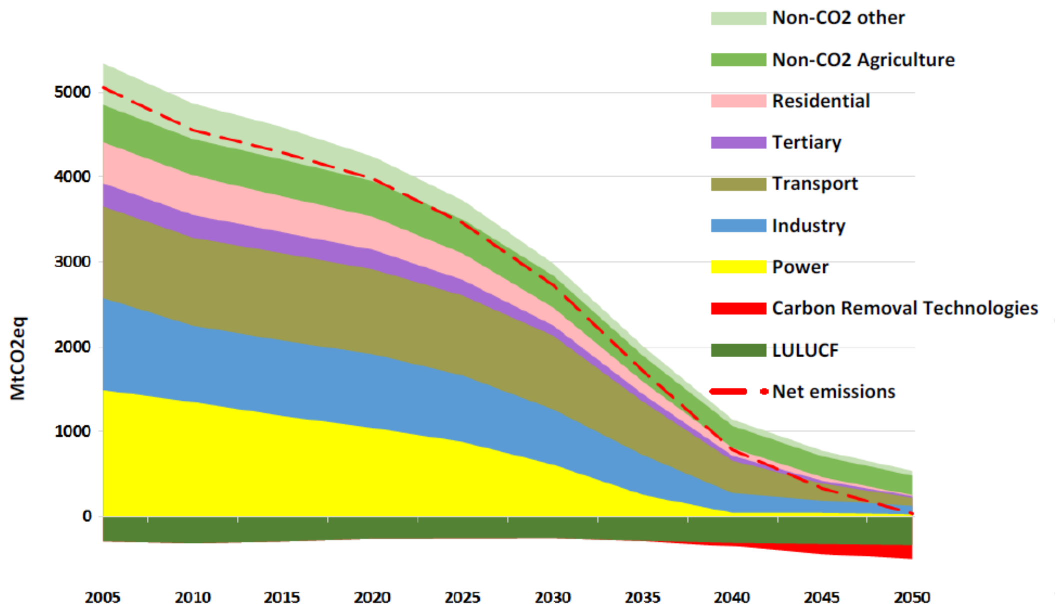
- We first explain some of the challenges that may arise with ongoing decarbonisation of the EU economy.
- We then discuss how the gas system might help address these challenges.

1.1 The energy transition will create challenges regarding the transportation and storage of energy

The new EU Commission has proposed a "European Green Deal" which will look to enshrine "climate-neutrality" in law by 2050 and tighten existing greenhouse gas (GHG) emission reduction targets for 2030.[2]

Achieving **carbon neutrality will require decarbonisation across the economy**, including in sectors currently reliant on natural gas (and other hydrocarbon fuels; Figure 1).

Figure 1 Decarbonisation across all sectors is required to meet EU 2050 climate targets



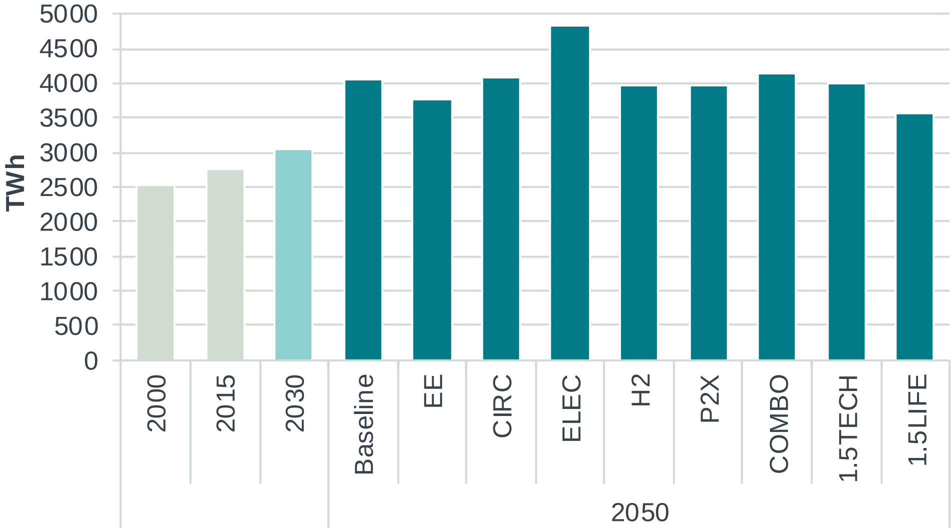
Source: EC (2018), "A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy", COM(2018) 773 final Brussels, 28.11.2018

[2] "Communication from the Commission: The European Green Deal", COM/2019/640 final.

While there are clearly some uncertainties regarding the make-up of the future energy system, our review of existing analysis, carried out for the European Commission[3], shows that the **gas sector has a long term role to play** in the European energy transition.

Looking across the studies reviewed, one key theme is that final energy demand is expected to fall to 2050, driven by reductions in heating demand (in buildings and in industry) as well as by a shift to more energy efficient modes of transport. Part of this fall in overall energy demand is expected to be driven by increased electrification of heating, cooling and transport. However, while overall energy demand may fall, increased electrification is also expected to lead to an **increase in final electricity demand** (Figure 2).

Figure 2 EU-28 final electricity demand across different scenarios



Source: *Frontier Economics and CE Delft (2019), "Potentials of sector coupling for decarbonisation". The underlying data was sourced from scenarios presented in European Commission (2018) "A Clean Planet for all, A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy".*

There are significant uncertainties as to how this electricity demand will be met in the future. Nuclear power is politically acceptable in only a subset of countries. Other low carbon dispatchable generation technologies (e.g. thermal generation with carbon capture and storage) may play a material role. However, to achieve the overall climate targets, **much of this increase in electricity demand will need to be served by renewable sources**, including intermittent solar photovoltaic (PV) and wind energy.[4]

Given the likely increased intermittency on the electricity system, combined with the pattern of energy demand in most parts of Europe, which is highly seasonal (peaking in winter for heating purposes in many Member States), one **challenge**

[3] Frontier Economics, CE Delft et al (2019), "Potentials of sector coupling for decarbonisation: Assessing regulatory barriers in linking the gas and electricity sectors in the EU : intermediate report".

[4] Ibid, footnote 6: "*Asset (2018) reports a RES share in power generation in the EU slightly above 70% by 2050 (around 50% in 2030). IRENA (2018) reports a 94% share of renewable energy in power in the EU for the 2050 REmap scenario. Greenpeace (2015) reports a 95% in the [Energy Revolution] scenario (66% in 2030), and 100% in the [Advanced Energy Revolution] scenario (70% in 2030) for OECD Europe (including Israel and Switzerland) in 2050.*"

for a decarbonised EU energy system will be flexibility of energy provision, including over seasonal timescales. And given that new energy production may not be necessarily located close to demand centres, **another challenge will be ensuring the cost-effective transport of energy**.

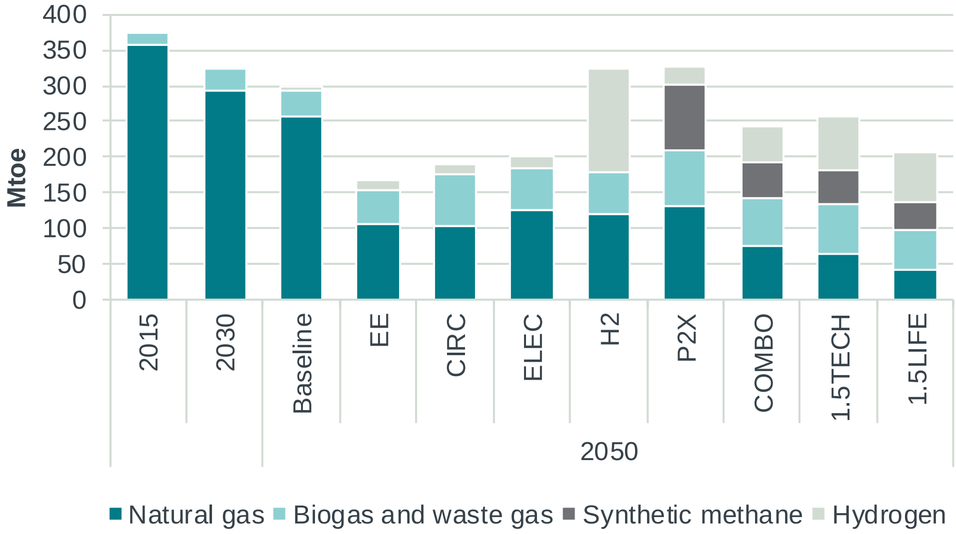
1.2 The gas system is well-placed to help address these challenges

Continued use of **gases can contribute to addressing both of these challenges**. For example:

- Gas infrastructure can be used to efficiently **store large energy volumes** over weeks, months and seasons. By contrast, it would not be efficient to store electricity in large volumes and over longer periods using storage technologies such as batteries. Energy storage in the form of gas clearly benefits from the high energy density in gas as compared to electricity.
- Direct transmission of electrons via electricity infrastructure is not necessarily the most cost-effective means of transporting energy even in an era of electrification. It may be **more cost effective to transport renewable or low-carbon energy,** from where it can be most efficiently and naturally produced to where it is consumed, in an original gaseous form or even (despite efficiency losses in conversion) by converting it to gas (from electricity) and transporting the energy using gas infrastructure. This may apply both to long-distance transport, for example from offshore wind facilities to demand centres, and to local distribution.

It is therefore likely the **gas sector has a long term role to play, provided it increasingly decarbonises.** This is consistent with the results of most studies we have reviewed, though overall gas demand (and the demand for different gases) is clearly uncertain (see Figure 3).

Figure 3 EU-28 demand for gases across different scenarios

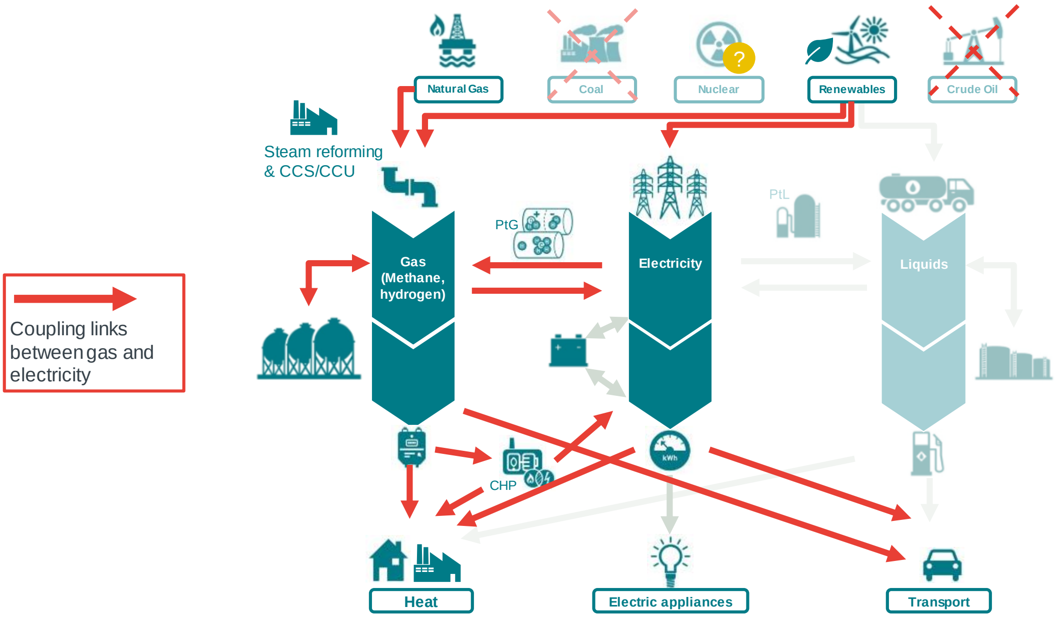


Source: *Frontier Economics and CE Delft (2019), "Potentials of sector coupling for decarbonisation" The underlying data was sourced from scenarios presented in European Commission (2018) "A Clean Planet for all, A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy".*

Many renewable and low-carbon gas production technologies exist or are in development and have the potential to make a significant contribution to this decarbonisation (Figure 3). Examples of renewable gases include biogas and its upgrading to biomethane. Hydrogen produced by reforming natural gas could (in combination with carbon capture and use or storage) be considered "low-carbon" (although not renewable). Production of synthetic gases from electrolysis (also referred to as "power-to-gas", or PtG) could be classed as either renewable or low-carbon, depending on the source of electricity used.

Increasing use of PtG technologies (and other technologies, such as hybrid heat pumps) will result in a **closer linking between the electricity and gas sectors** than is currently the case (see Figure 4).

Figure 4 Growing links between electricity and gas



Source: Frontier Economics

1.3 This study aims to evaluate and recommend policy options to support decarbonisation of the gas sector

In light of these expected changes to the energy system, and to understand the potential appropriate policy response(s), EFET asked us to consider the following questions:

1. How could the EU and national governments mandate measures to transform the natural gas sector into a contributor to decarbonisation of the economy, rather than a source of carbon emissions?
   a. What type of measures will be most economically efficient?
   b. How might measures be compatible with the EU Emissions Trading Scheme?
   c. Could one possible solution be pan-European tradeable certificate system setting a timetable for decarbonisation of the gas system?
2. What measures can help the gas system contribute to flexibility in the electricity system (to the extent needed and valued by the market)?

We consider these questions in the rest of the report:

- Section 2 analyses the current policy landscape for gas decarbonisation and sector coupling, and considers the implications for the energy transition if the framework is left unchanged;
- Section 3 evaluates the potential options for reforming the climate policy framework to support gas decarbonisation; and
- Section 4 sets out our recommendations for policymakers.

2 THE CURRENT POLICY LANDSCAPE IS FRAGMENTED AND DOES NOT SEND CONSISTENT SIGNALS FOR GAS DECARBONISATION

In this section, we analyse the current policy landscape for gas decarbonisation and sector coupling, and consider the implications for the energy transition if the framework is left unchanged.

- We describe current EU climate policy, highlighting gaps and overlaps in the framework.
- We set out how wider market arrangements may also distort choices between different technologies and energy carriers.
- We summarise the key shortcomings of the current policy framework.

2.1 The current climate policy framework is not optimally designed

2.1.1 The current framework has both policy gaps and policy overlaps

At EU level, key elements of the policy framework for pursuing decarbonisation were all updated during the tenure of the previous Commission.

The **EU Emissions Trading System** (ETS) now sets a binding target for GHG emission reductions in the sectors it covers of 43% by 2030 compared to 2005 levels. CO_2 emission allowance (EUA) prices have risen significantly following the adoption of the revised ETS Directive[5], which included provisions for a Market Stability Reserve (MSR). Prices averaged EUR 25/tCO_2e during 2019. The ETS currently covers power generation[6], heavy industry and intra-EU flights.

The **Effort Sharing Regulation**[7] sets out binding emissions reduction targets for Member States in sectors falling outside of the scope of the EU ETS for the period 2021-30.

The recast **Renewable Energy Directive** (RED II)[8] sets a binding target for output from renewable energy sources (RES) as a percentage of final energy consumed of at least 32% at EU level. It includes sectoral sub-targets for heating and cooling and transport. Member States are now required to submit integrated National Energy and Climate Plans (NECP) outlining how they will contribute towards EU-wide targets over the period 2021-2030, including the renewables target.

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5 OJ L 76, 19.3.2018, p. 3–27.

6 Mandatory only for installations over 20MW.

7 OJ L 156, 19.6.2018, p. 26–42.

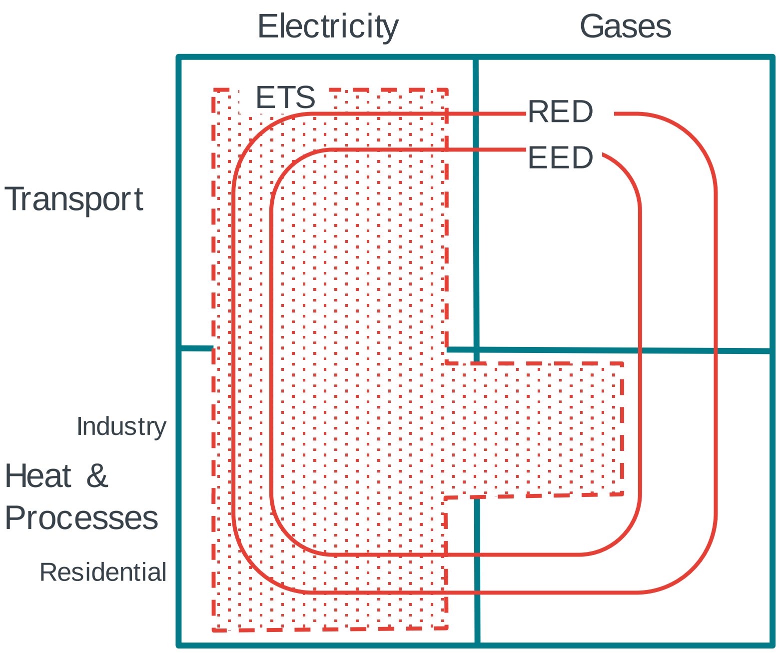
8 OJ L 328, 21.12.2018, p. 82–209.

The **Energy Efficiency Directive** (as amended 2018)[9]:

- Sets an increased binding energy efficiency target at EU level, implying a maximum consumption of 1273 Mtoe of primary energy and 956 Mtoe of final energy in 2030 (compared with actual primary energy supply of 1624 Mtoe and final energy consumption of 1060 Mtoe in 2017); and
- Extends the energy savings obligation in end use, obliging EU countries to achieve new energy savings of 0.8% each year of final energy consumption for the 2021-2030 period.

The current European policy framework is summarised in Figure 5 below. It illustrates if and to what degree the three main policy instruments (EU-ETS, RED II and EED) apply to the energy carriers in the scope of this report, namely electricity and gases, and the main consuming sectors, notably transport, heat and processes. We discuss this further in the following sub-section.

Figure 5 Sectoral coverage of current climate policy arrangements



Source: Frontier Economics.

2.1.2 These problems lead to inefficiency

For the gas sector there are **gaps** in the current climate policy framework. In addition, policy instruments may **overlap** (Figure 5). This **undermines the effectiveness and efficiency of the framework**. To give some specific examples:

- **Incomplete coverage of the EU ETS leading to inefficient abatement activities:** Some sectors (power generation and heavy industry) are covered by the EU ETS, while others (buildings, light industry, and road and maritime transport) are not. This will either lead to insufficient abatement in sectors that are not covered by the ETS, or the implementation of alternative policies in the

[9] OJ L 328, 21.12.2018, p. 210–230.

sectors not covered, that could lead in turn to conflicting signals and abatement activity across Member States and across different sectors. [10]

- **Overlapping policies leading to inefficient abatement activities:** There is currently no specific mechanism to ensure the EU ETS automatically adjusts to account for the impact of policies implemented under RED II and the Energy Efficiency Directive. For example, support schemes for RES-E and combined heat and power (CHP) have historically reduced (and continue to reduce) demand for EUAs from the power sector, lowering the EUA price (since the ETS cap is not automatically adjusted for the abatement driven by other instruments). The lower EUA price reduces the incentive under the ETS for the uptake of abatement measures that might have been cheaper than those driven forward by RES-E and CHP support schemes.
- **Incomplete coverage of RED II leading to inefficient low carbon gas investment:** RED II sets targets for the proportion of consumption of energy from renewable energy sources, but does not do so for non-renewable (though potentially still low-carbon) alternatives. Such alternatives include hydrogen produced from natural gas using carbon capture technologies or synthesised by electrolysis using power from nuclear. The differential treatment of renewable and other low carbon forms of energy may result in inefficient decarbonisation in the gas sector.
- **Failure to coordinate low-carbon gas support policies across Member States leading to inefficient abatement activities:** RED II is mainly facilitative as opposed to requiring particular actions to be taken to meet renewable energy targets. Apart from support for RES-E and the provision of a framework to allow monetisation of customers' willingness to pay for renewable energy (by mandating the issuing of guarantees of origin) there is little detail in RED II (or in the Energy and Environment State Aid Guidelines, or "EEAG") on what form support for renewable energy should take in order to ensure targets are met. Outside of electricity, for example, the EEAG do not require that competitive tenders are used for RES support schemes or that producers be exposed to market price signals. This leaves scope for Member States to take differing approaches to promoting renewable gases. This in turn may lead to abatement activities which are not least cost on an EU-wide basis.
- **Insufficient harmonisation of energy taxes leading to inefficient abatement activities:** The Commission services themselves have found[11] that the Energy Taxation Directive (ETD)[12] could lead to inappropriate price signals by discouraging consumers from choosing cleaner fuels. More generally, the lack of harmonisation of national fiscal regimes covering fossil fuels may lead to potential distortions in trade between Member States.

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[10] Even in sectors covered by the EU ETS, the system of free allocation of EUAs may result in incentives to decarbonise being diminished. For example, for hydrogen production, the volume of free allocation is calculated based on the direct emissions associated with hydrogen production (and is linked to historical production levels). This reduces incentives to switch from conventional hydrogen production to alternative, potentially lower emission, production methods. This is described further in Frontier Economics et al (2019), "Potentials of sector coupling for decarbonisation: Assessing regulatory barriers in linking the gas and electricity sectors in the EU : final report", section 5.2.4.

[11] "Evaluation of the Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity", SWD(2019) 332 final, p. 63.

[12] OJ L 283, 31.10.2003, pp. 51-70.

- **Unclear policy objectives leading to inefficient behaviour:** There is a lack of a standardised approach to measuring and valuing GHG emissions associated with different technologies, with a "lifecycle" measurement approach being discussed in some areas (e.g. biofuels) but not in others (e.g. batteries). This could lead to activities which do not, from an end-to-end perspective, contribute optimally to carbon abatement.

2.2 Wider market arrangements may also distort choices between different technologies and energy carriers

In addition, there **may not currently be a level playing field** between technologies and different types of infrastructure due to broader factors (i.e. outside of climate policy). If left unresolved, these issues may **prevent the gas system from providing an efficient level of flexibility** to the energy system. These issues are described in further detail in our recent report for the Commission[13], and we briefly describe them below.

2.2.1 Wholesale market design does not always result in players internalising the impacts their actions have on the system

The **costs, tariffs and charges faced by market participants** (for example, connection charges, grid tariffs and imbalance charges)**, and the revenue streams they can earn** (for example ancillary service revenues)**, often do not reflect the wider costs and benefits** their actions have on the energy system. Sector coupling makes the potential consequences of this potentially more significant: for example, a power-to-gas facility may have impacts on future network reinforcement costs and balancing costs across the electricity and gas grids.[14]

Correcting for this will require further reforms at both national and EU level, such as changes in grid tariffs, ensuring full remuneration for contributions to adequacy and complete markets in flexibility, in addition to the full implementation of existing internal energy market legislation, including network codes. One example of the changes required to ensure enhanced locational signals, as noted in our report for the Commission[15], would be market-based compensation for congestion management at transmission and distribution level.

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[13] Frontier Economics et al (2019), "Potentials of sector coupling for decarbonisation: Assessing regulatory barriers in linking the gas and electricity sectors in the EU : final report", available at the following link: https://ec.europa.eu/energy/en/studies/potentials-sector-coupling-decarbonisation-assessing-regulatory-barriers

[14] Further complications may arise in assessing the effects of taxes and subsidies elsewhere in the value chain: for example, the effect of agricultural subsidies on biomethane production or the effect of subsides for renewable electricity on wholesale prices and, in turn, on synthetic gas production.

[15] Ibid, p. 72.

2.2.2 The structure of levies and tariffs can also distort the playing field

The design of other **taxes, levies and tariffs** used to recover irreversibly incurred costs can also **distort the playing field**. For example, as noted in our report for the Commission:[16]

> *"…there is a risk that, with declining volumes of gas transported, unit tariffs would need to increase to ensure recovery of sunk costs (i.e. those costs associated with legacy investments that have been irreversibly incurred and which do not vary with consumption).*
>
> *"[This] might in the medium and long term undermine the affordability and competitiveness of gas. It may incentivise switching away from gas to other energy carriers, to an extent that might not be cost effective from a societal perspective (because the increase in tariffs would not be cost reflective)."*

In addition, levying energy taxes on the electricity used by conversion facilities such as PtG may disadvantage them compared to alternatives forms of gas production that do not face such taxes.[17]

Discussions regarding the appropriate way in which to recover sunk costs and revenues for financing public goods are not necessarily new. However, the sector coupling narrative adds an additional layer of complexity. It means that **gas and electricity (and other energy carriers) might increasingly be viewed as substitutes**. There is therefore a **need to avoid distorting choices between them**, and ensure that price differentials reflect only real underlying differences in cost to society (for example, differences in technology costs, system costs or environmental externalities).

2.2.3 Unless network operators' biases are overcome, the cost of supplying energy may be higher than necessary

Electricity and gas **network investment will need to be optimised across electricity and gas**, taking into account the capabilities of other infrastructure developments. It is true that the activities of electricity and gas network operators are gradually becoming more co-ordinated**.** For example, ENTSOG and ENTSO-E now carry out joint scenario planning and are developing an integrated electricity and gas model. However, beyond supporting the general objective to more closely link their respective Ten Year Network Development Plan (TYNDP) process, it is as yet unclear how the ENTSOs will use this model in practice, or whether it will result in changes to investment decisions.

Furthermore, increased co-ordination does not, in and of itself, overcome any **bias individual grid operators may have** towards infrastructure solutions involving the type of assets for which they are responsible (gas or electricity respectively). Addressing this is primarily a regulatory issue. At the **national level, regulators**

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[16] Ibid, p. 59.

[17] Ibid, p. 58.

should have tools to incentivise optimised solutions (looking across gas and electricity, and across transmission and distribution). Beyond this, ensuring efficient infrastructure plans has a **significant cross-border dimension**, and both regulators and TSOs need to work together to ensure **effective international optimisation**. Some instruments (such as cross border cost allocation and support from EU funds such as the Connecting Europe Facility) are in place, but these do not necessarily impact optimisation at the planning stage, and it is likely that more action will be required.

2.3 The current context increases the risks of an insufficient or inefficient energy transition

Given the gaps and overlaps in the current climate policy framework and the lack of a level playing field in wider market arrangements, there are **risks** that, absent further policy change:

- There are insufficient signals for innovation (in the gas sector in particular);
- Investments to support decarbonisation (again, in particular, in the gas sector) do not happen at the necessary scale;
- Looking across the energy system, the lack of a level playing field between technologies (looking across the energy sector) result in significant inefficiency in the way investments take place
- Customers pay more than necessary for the energy transition.

The **lack of clear market signals may also result in pressure to rely on regulated entities to make investments in or operate infrastructure,** which could be developed competitively. Regulated company involvement in certain types of infrastructure (such as networks) may continue to be relevant, and regulated entities may have important roles to play in trialling and piloting of technologies and the integration of value chains where co-ordination barriers arise.[18] However, if policymakers succumb to such pressure outside specific areas, it will reduce competition, and lead in turn to a threat to innovation, and an increased likelihood of customers paying too much for the wrong investments in the wrong places.

[18] For examples of potential coordination issues, see p.46-48 of Frontier Economics et al (2019), "Potentials of sector coupling for decarbonisation: Assessing regulatory barriers in linking the gas and electricity sectors in the EU : final report".

3 THERE ARE A NUMBER OF POTENTIAL SOLUTIONS, ALTHOUGH NO "SILVER BULLET"

In this section, we evaluate the potential options for reforming the climate policy framework to support gas decarbonisation:

- We first set out some high-level considerations in relation to the overall framework.
- We then describe the options we consider further, and assess their ability to contribute to effectively and efficiently meeting the EU's decarbonisation goals, considering in turn:
  - Carbon pricing;
  - Support mechanisms; and
  - A comparison of different types of support mechanisms.

3.1 Clarity on policy objectives and the use of markets and incentives is a critical starting point

The first steps in any updated climate policy framework must be the following:

- **Define an overall decarbonisation ambition:** If climate protection is the main objective, it would be preferable for this ambition to be defined in terms of economy-wide decarbonisation, though we recognise policymakers may wish to define sub-targets in relation to heating, cooling and transport or may even perhaps set gas-sector specific targets for a transitional period. In the long run, sector specific sub-targets should be avoided and it should be left to market-based signals to direct decarbonisation efforts into those sectors where abatement can be achieved at least cost.
- **Define unavoidable limitations on the role of market incentives in meeting this ambition**: There are clear benefits to the use of markets and incentives to deliver decarbonisation. However, **some aspects of the transition** (such as switching over whole gas distribution areas to use of hydrogen) **will require significant coordination –** markets and incentives alone may not be sufficient to deliver effective outcomes in such areas. Policymakers should clearly set out how such limitations will be considered.

Policymakers can then turn to how best to harness the market to deliver **incentives to achieve this decarbonisation ambition**. This requires a **coherent framework** that rewards carbon abatement in a **market-based, technology neutral** way. Ideally this framework could **eventually work across gas, electricity and other energy carriers** (such as liquid fuels) so that a consistent framework is applied across multiple fuels. It should comprise elements that provide a "pull" for demand for cost-efficient carbon abatement as well as a "push" for the supply of low-carbon energy, or ideally, a combination of the two.

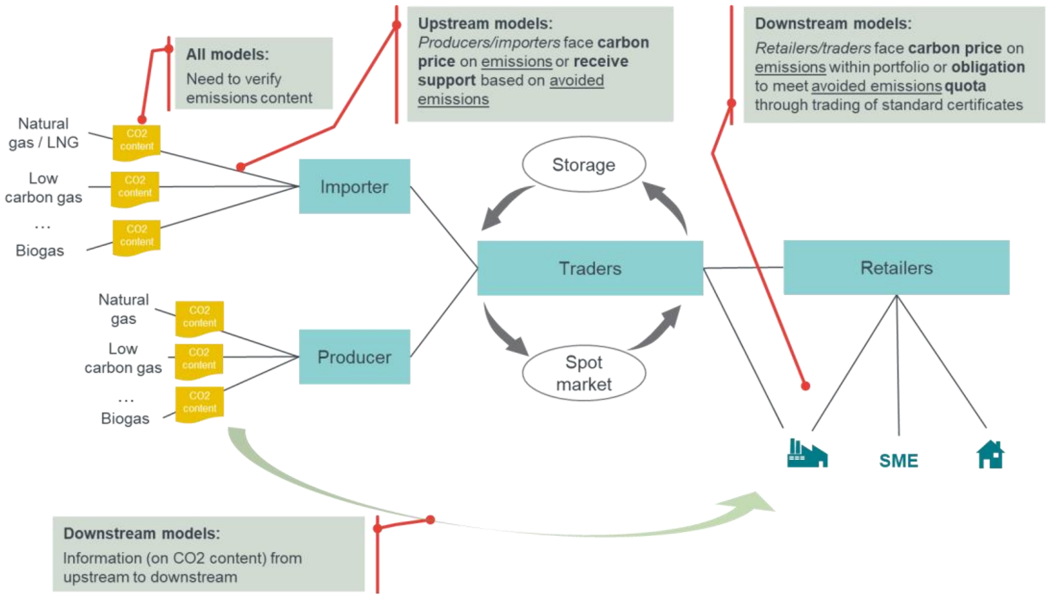
3.2 Carbon pricing and support mechanisms can both incentivise relevant investments

Frontier has assessed the relative merits of two high-level models (alongside ongoing research and development to bring technology costs down) that could form part of this framework:

- **Carbon pricing schemes**, such as the ETS, which provide a penalty for high carbon activity and an incentive for low carbon technology, affecting incentives upstream ("push") as well as downstream ("pull"), regardless of the level of the value chain at which carbon pricing is legally implemented; and
- **Support mechanisms,** which could be used to incentivise low carbon technology or avoided emissions.[19] Within support mechanisms, we have considered both:
  - An **"upstream" approach based on tenders**, providing a technology "push"; and
  - **Tradeable certificate schemes**, whereby quotas to achieve a given amount of decarbonisation would be set for retailers, which they could fulfil by trading and redeeming standard certificates, originated by qualifying producers, creating a demand ("pull") for avoided emissions.

The different models are illustrated in the figure below.

Figure 6 Illustration of different options for providing decarbonisation incentives



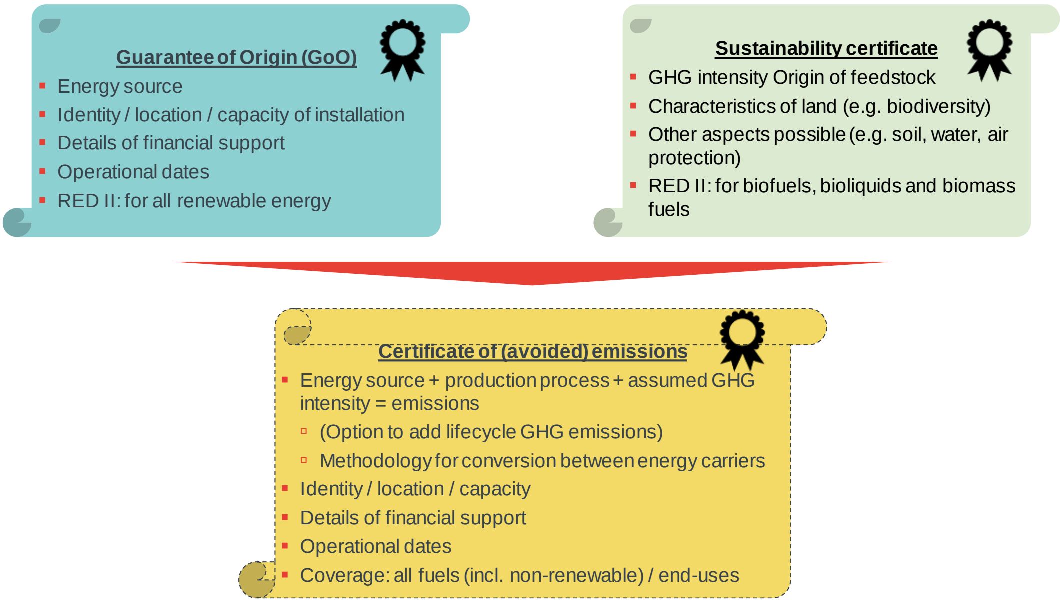
Source: Frontier Economics.

[19] The status quo of climate policy for the electricity sector might best be described as a hybrid system. The EU ETS introduces carbon pricing which incentivises the switch to lower emission production at the margin, but much of the renewable build-up has been incentivised through subsidy schemes. The ETS is targeted at large conversion installations (from primary energy to electricity), and therefore does not directly cover all energy users, but also does not exclusively address importers or producers.

Both of these models require a common way of describing the carbon content of low-carbon gas (this will depend on the type of gas and its manufacturing process). Such a system **could combine and extend elements of existing instruments** (such as Guarantees of Origin and Sustainability Certificates required under RED II). The ultimate objective would be to define a "common currency" that would help determine the extent to which different gases should be rewarded (or penalised), depending on their carbon content (which could include "lifecycle" impacts, if so desired by policymakers).

Within a support mechanism, such a common currency could, along with the mechanism itself, eventually be extended to electricity and other energy carriers, although there are complexities in achieving this[20].

Figure 7 A "common currency" for certifying the emissions of different gases



Source: Frontier Economics

[20] Whereas consumption or production of a unit of low carbon gas can reasonably be assumed to offset production or consumption of natural gas, which has a relatively well specified carbon content, this is not the case for production or consumption of a unit of renewable electricity, where the carbon saving can vary significantly over time depending on the particular technology mix in the remainder of the electricity system.

Figure 8 The role of fossil fuel use prohibitions in the transition

While the focus in our report is on market-based approaches to incentivising decarbonisation, policymakers may also choose to implement non market-based approaches. Specific prohibitions on hydrocarbon fuel use, such as the plans by several EU member states to phase out coal-fired electricity by a certain date, or proposed bans on the installation of gas boilers in certain types of housing, are examples of such non-market approaches.

Such approaches may be an appropriate way of meeting specific policy objectives (such as a desire to phase out particular fossil fuel technologies – see section 3.1). However, in many situations they risk increasing the costs of meeting broadly-defined decarbonisation objectives.

In particular, such prohibitions may be less appropriate if policymakers are unsure which technologies are likely to be cost-effective in future. For example, an outright ban on gas boilers may encourage investment in alternative heating technologies. But equally it may not be the most cost-effective policy response if there is a prospect of boilers running on low-carbon gas supply (at reasonable cost) in the future.

3.3 Both market-based approaches (pricing carbon or supporting abatement) are credible – neither is without its issues

3.3.1 Carbon pricing is likely to be the most efficient long term solution

Credible carbon pricing is likely to be the most efficient solution, and it is probably best applied downstream (at the point the fuel is burned). It is clear from the plans for a European Green Deal that there is a political commitment to the EU ETS. The proposal to tighten it and legally bind the EU to "climate neutrality" could bolster the ETS price both due to any actual tightening of the ETS cap and to any increase in the scheme's longer-term credibility.

The Commission's proposals to extend the ETS (to buildings and road and maritime transport) and reform the ETD[21], could, if implemented, result in greater consistency of carbon pricing across most sectors of the European economy. This in turn would help encourage uptake of **least cost emission reductions** measures.

EU-level, **economy-wide, carbon pricing should therefore clearly be the long-term goal** for policymakers. However, compared to support-based approaches which can limit windfalls for existing low-carbon producers (as well as the costs for existing high-carbon producers), **carbon pricing-based approaches can – under certain circumstances – result in higher energy prices for end-consumers**. This can create affordability concerns for domestic consumers. For business consumers, competitiveness concerns may arise in relation to increased energy prices and increased costs of their own carbon emissions. For businesses that trade internationally, this raises the possibility of carbon leakage.

Policymakers have typically tried to address the negative distributional impacts of energy policies within the energy sector, for example by granting relief to (selected)

[21] "Communication from the Commission: The European Green Deal", COM/2019/640 final.

consumers from certain energy charges. If such an approach were to be applied to carbon pricing, it would diminish its efficiency and effectiveness. However, it is **possible to address the distributional impact of carbon pricing in other ways while ensuring market players remain exposed to the carbon price.** For example, impacts on energy prices can be addressed through fiscal transfers such as tax rebates or direct payments, both within and between[22] Member States. The Commission's proposal for a **carbon border adjustment mechanism** could, if practical implementation issues can be overcome, be an **effective tool for addressing carbon leakage** to an extent. For gases, such a mechanism could be applied to imports based on their carbon content, to ensure a level playing field between domestic and foreign production.

Successfully managing the distributional consequences of carbon pricing will be critical to ensuring its political stability and credibility, which in turn will allow it to provide the long-term investment signal needed. Conversely, (political) constraints on the ability to manage these distributional impacts may ultimately undermine or at least delay the achievement of longer-term credibility of a carbon pricing-based approach – especially since carbon prices would likely need to rise significantly to meet longer-term GHG emissions reduction goals.[23]

3.3.2 If well designed, support mechanisms can drive investment and provide benefits, not least as an interim measure

While ultimately unlikely to be as efficient as a long term credible carbon price (see further detail below), **support mechanisms for low-carbon gas production can address some of these concerns**. They can be designed in ways which ensure investor certainty (see section 3.3.3 for further detail). And even if the costs of support are recovered from energy consumers, **their impact on consumer energy prices ought to be lower, compared to carbon pricing,** given support can be targeted to new investment (and avoid windfalls to more established technologies).

Support may also be a more appropriate transitional mechanism for encouraging the required technological cost reduction during the transition period while technology costs are still falling. Figure 9 below illustrates this with a simplified example.

- Electrolysis technologies are eventually expected to fall in cost. We estimate the carbon price required to encourage switching from natural gas to hydrogen produced from renewable electricity could (excluding infrastructure and appliance costs) be around EUR 100-330/tCO_2e by 2050.[24] This would be

[22] To this end, the Commission has proposed a Just Transition Mechanism, including a Just Transition Fund, to assist EU regions currently most dependent on fossil fuels, by aiding them in the energy transition.

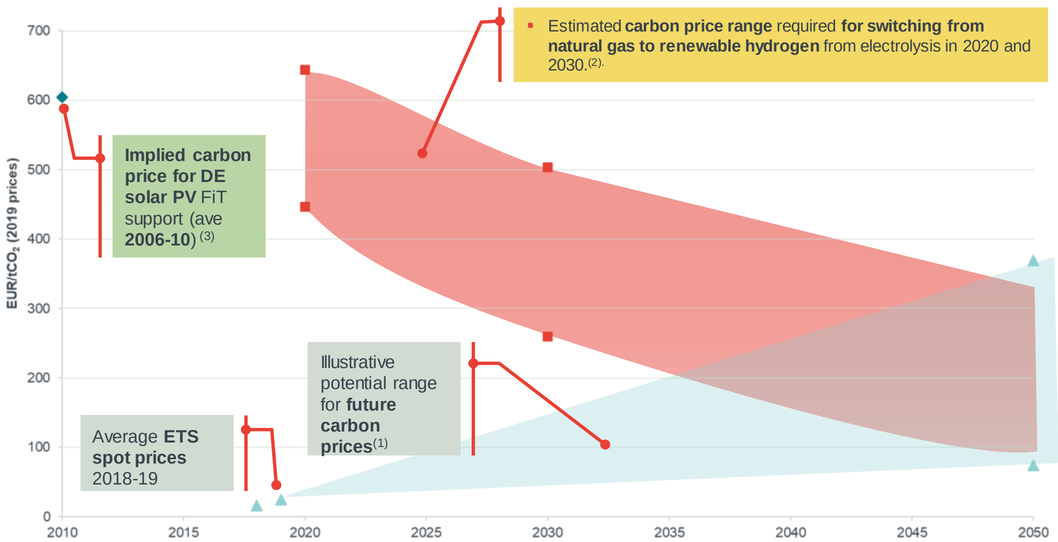
[23] The EBRD uses "shadow" prices for carbon for 2050 in the range EUR 74 – 147/tCO_2e (based on the recommendations of the High Level Commission on Carbon Prices). The European Commission's recent Long Term Strategy paper estimates even higher prices: EUR 250/tCO_2e under the 80% reduction scenarios and EUR 350/tCO_2e under the scenarios that achieve net zero GHG emissions by 2050

[24] The figures presented here are our calculations, based on the spreadsheet tool associated with the study by Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018) "The Future Cost of Electricity-Based Synthetic Fuels". We have calculated the breakeven carbon price for clean hydrogen (compared to natural gas), based on "Reference" case assumptions for hydrogen produced from electrolysis in North African solar, including the cost of export to Germany. The estimates presented exclude the cost of upgrades to gas infrastructure and appliances. Estimates of the breakeven carbon price are sensitive to a

within the range of future carbon price estimates[25], and consistent with the idea that carbon pricing should be sufficient in the longer-term to ensure gas decarbonisation.

- However, electrolysis technologies are currently in the early stages of commercial deployment for energy applications. We estimate the breakeven carbon price for clean hydrogen in 2020 to be around EUR 445-645/tCO_2e in 2020. This is clearly far in excess of the current carbon price (around EUR 25/tCO_2e).
- A tightening of the carbon constraint in a reformed ETS merely to ensure deployment of electrolysers today would therefore impose significant costs on the economy as well as consumers (as CO_2 prices for all market participants would rise to very high levels, reflecting the cost of expensive abatement options). Targeted support mechanisms can help to drive down technology costs, but with fewer distributional consequences, by differentiating the support more by technology band.[26]
- Indeed, such a logic has been a large part of the rationale for support to renewable electricity production over the last decade. Figure 9 also illustrates that the implied cost of historical support to German solar PV, expressed in terms of cost per tonne of carbon abated, is around EUR 600/tCO_2e in today's prices. This is within the range of current estimates of the cost of hydrogen production from electrolysis.

Figure 9 Cost of hydrogen from electrolysis compared to carbon price



Source: Frontier Economics, based on sources indicated below.

Note: (1) See footnote 23. (2) see footnote 24. (3) Marcantonini and Ellerman (2014) "The Implicit Carbon Price of Renewable Energy Incentives in Germany", EUI working paper.

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number of assumptions, including the cost of electricity, hydrogen production technology cost and the counterfactual fuel (i.e. natural gas or conventional hydrogen). The range presented is based on the "optimistic" and "pessimistic" scenarios from the Agora/Frontier study.

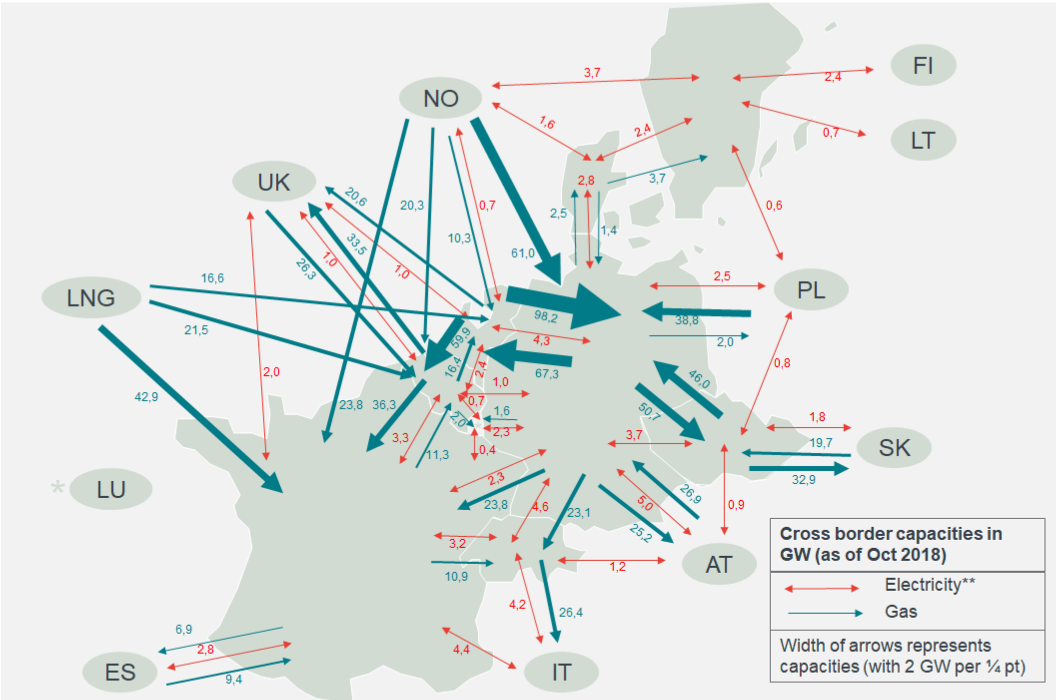
[25] See footnote 23. We acknowledge there is an element of circularity in making such comparisons (since estimates of shadow carbon prices will themselves depend on estimates of technology costs), though we make it only for illustrative purposes.

[26] See also footnote 28.

Support mechanisms will clearly be less efficient as a main driver of GHG emissions abatement than a harmonised carbon price at EU level:

- They focus on the supported technologies, and as such **do not have a cross-economy impact**. They may not sufficiently disincentivise carbon-intensive production or imports.
- If they are not accompanied by the use of competition in selecting projects and technologies to be subsidised, errors in setting support levels could result in significant unnecessary costs to customers.
- There is significant potential for them to be established on a national (rather than cross-EU) basis.[27] **If support schemes for gas decarbonisation are not co-ordinated at the EU level and open across borders, deployment costs will be substantially increased** (from an EU-wide perspective). Instead of optimising production across the EU so that it takes place where it is cheapest, and then taking advantage of trading opportunities within the EU, the geographic pattern of low-carbon gas production would instead be dictated by the availability of national support. Given the substantial capacity for trade in gas within and across the borders of Europe, the costs of a national approach would be much higher for gas than for electricity (see Figure 10).

Figure 10 Cross-border transport capacities for gas and electricity between eight countries* analysed



Source: *Frontier Economics and IAEW (2019), "The value of gas infrastructure in a climate-neutral Europe".*

Note: **The countries analysed as part of the above study were Belgium, Switzerland, the Czech Republic, Germany, Denmark, France, the Netherlands and Sweden.*

[27] We note there have been strong political objections to opening of RES-E support schemes in the past.

3.3.3 Both upstream and downstream support mechanisms have merits

As noted above, we consider two different types of mechanism for support for avoided emissions:

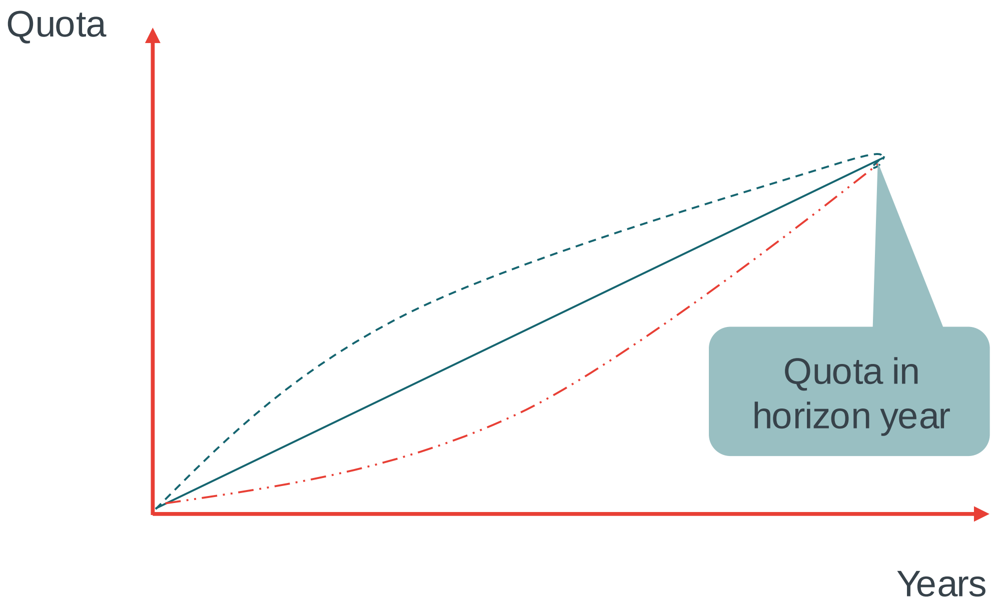
- An “upstream” approach based on tenders (e.g. to support the production of, or conversion into, low-carbon gas); and
- Tradeable certificate schemes, whereby quotas to achieve a given amount of decarbonisation would be set for retailers (e.g. a requirement to procure a certain percentage of gas sales from low-carbon sources), which they could fulfil by trading and redeeming standard certificates, originated by qualifying producers.

Both types of mechanism would support the achievement of overall decarbonisation goals (and indeed could be eventually broadened from gases to cover all forms of energy). In the case of tenders upstream, policymakers would need to ensure that ongoing tendering meant there was sufficient deployment of low-carbon gases to meet overall decarbonisation goals. The tender process would allow policymakers control over support budgets.

In the case of a **tradeable certificate scheme, a clear pathway and timetable for decarbonisation should ideally be built into the scheme design** itself (i.e. a tightening of targets year-on-year). Alternative paths to meet the quota (e.g. of low carbon gas content in the gas sold) in the horizon year are possible. The optimal path depends on the potential of different technologies (see Figure 11):

- A linear glide path would reflect steady progress and few non-financial constraints on any technology.
- If one technology has significant potential and can be developed very quickly, a concave path (top line) may be more appropriate.
- Alternatively, if the potential of an important technology cannot be realised for a some years e.g. for planning reasons, then a convex path (lower line) on might be more appropriate.

Figure 11 Alternative quota paths



Source: Frontier Economics.

Both types of mechanism require a substantial degree of policy input. Firstly, both approaches require political decisions regarding the specific level of decarbonisation ambition in the gas sector, with a risk of setting this at inefficient level, such that the cost of overall energy supply may exceed optimal levels. Furthermore, both schemes require policymakers to determine eligibility rules for production and conversion technologies, and both can incorporate design features that minimise rents and promote a diverse range[28] of technologies:

- For tenders, through use of technology-specific reserve/ceiling prices and/or maximum/minimum volumes/budgets; and
- For certificate schemes, through the use of banding (where emission reduction through less mature technologies is valued higher than through more established technologies).

Both types of mechanisms can also be designed to increase certainty for investors.

- In the case of tenders, this is achieved through the possibility of longer-term contracts, and also through political commitment to avoid “stop and start” support.
- For certificate schemes, it is important that:

28 Awarding support on a technology-neutral basis through competitive processes fuels competition between technologies and creates strong incentives for technologies to bring costs down to capture greater market share. However, there may be a case for differentiation of support in order to ensure the development of technologies that are less mature, but which have the potential to be cost-effective. This is likely to involve an element of subjective judgement, creating a risk that the wrong technologies are given additional support. Any such differentiation should therefore be restricted in time, with a clear timeline for the ending of any preferential treatment.

- appropriate penalties are in place if obligations are not met, and that the scheme is designed so there is not a "cliff edge" to prices if the defined obligation is met;
- there is a liquid market for certificates (this would, for example, be more likely to be the case if certificates were tradeable across borders);
- market participants trust that support levels will not be subject to (unexpected) change once investment decisions have taken place, and also that the scheme is there to stay (such that mechanisms to allow market participants to manage price volatility themselves – including so-called "banking and borrowing" of certificates – are feasible);

We note that the history of national quota and certificate schemes in electricity is one of repeated change and reform. Indeed, in many cases schemes transition over time to more centrally administered tender arrangements. This may undermine the potential trust of market participants in nationally conceived equivalent schemes for low carbon gases in the first place.

3.4 Any system needs to be accompanied by reform to ensure project developers face whole system price signals, and that network investment is optimised

Irrespective of the approach taken, as we noted in section 2, it is **important that developers of low carbon gas production facilities as well as other market participants face the right whole system price signals** (including in the form of connection charges, grid tariffs, congestion pricing ancillary service revenues and/ or imbalance charges). This is particularly true for power to gas technologies, where whole system price signals are needed both in relation to the electricity and the gas markets.

- Market arrangements should ensure that market participants face the forward looking costs their investment and operational choices cause (or the benefits they create) across the whole energy system. This will involve a mixture of measures such as ensuring complete markets for balancing and locational services to grid operators and changes to grid tariffs across electricity and gas to better ensure they reflect the costs imposed by participants (see section 2.2.1).
- Other costs (such as 'sunk' network costs and low-carbon energy support costs) should be recovered in a way which does not inefficiently distort behaviour (e.g. through creating incentives for charge avoidance, or through disincentivising uptake of low-carbon gas technologies requiring them to bear the legacy costs of past investment in the gas grid). This is primarily the responsibility of national authorities, though should also be borne in mind in the ETD and EEAG revision process, as well as in any revision to electricity and gas network codes covering network charging (see section 2.2.2).

Finally, to **ensure more optimal infrastructure investment decisions across electricity and gas, regulatory and institutional arrangements will need**

reviewing (see section 2.2.3). One possibility is that ACER and/or NRAs ensure that power and gas TSOs consider alternative solutions to their own infrastructure that may help to reduce overall system costs, including through setting appropriate regulatory incentives. Article 32 of the revised Electricity Directive[29] already requires Member States to ensure electricity distribution system operators procure flexibility from sources such as demand-side response and energy storage where this would be more cost-effective than investment in grid infrastructure. This principle should be extended across the energy system: to transmission, to gas networks and across the EU.

[29] OJ L 158, 14.6.2019, p. 125–199.

4 OUR RECOMMENDATIONS

Policymakers should set clear objectives for the decarbonisation of the entire economy, possibly including transitional sub-targets relating to gas use if that is judged necessary to stimulate initial investment (see section 3.1). Policymakers should also **be clear as to the benefits of the use of markets and incentives to deliver decarbonisation, as well as the limitations** of this approach where a more centralised co-ordination approach is required (such as for switching a region to a new type of gas).

In the **long-term**, a **harmonised EU-wide carbon pricing scheme** (e.g. one based on the EU ETS) should be seen as the **most efficient market-based measure** to achieve decarbonisation objectives, including decarbonisation of the gas sector (see section 3.3.1). The **expansion of the ETS to buildings, and road and maritime transport would be a key step** in the establishment of such a regime. As distributional issues are a key concern, **EU rules** (such as those on State aid and cohesion funds) **should provide Member States with the tools required to mitigate the potential distributional consequences** of such schemes.

Some countries may adopt **national carbon pricing approaches.**[30] Inconsistencies between national schemes and the ETS risk increasing the cost of energy supply beyond the minimum necessary. EU policy can help boost the credibility and effectiveness of national schemes by **setting a pathway for greater harmonisation between schemes and their eventual merging with an expanded EU ETS**.

In parallel, interim approaches should be accepted as a practical reality. In an **interim period**, the **policy framework should include market-based support mechanisms** for low-carbon gas production, which provide a more effective way of supporting early-stage commercial deployment than carbon pricing (see section 3.3.3). The **ETS should take into account the impact of support mechanisms** (e.g. by lowering the supply of ETS allowances provided to the market to take account of abatement achieved through interim support mechanisms), to **avoid them undermining the ETS through reductions in the price of EUAs**. The design of mechanisms should **also envisage the potential for them to be expanded to cover both electricity and low carbon gases** (and potentially other fuels).

The **design of support mechanisms should draw on learnings from the past experience** of RES-E support schemes (see section 2.1.2).

- Fixed **feed-in tariffs** with administered prices that give preference to individual technologies should be **avoided**. Instead, State aid rules and/or energy legislation should be clear that support should be awarded through a **competitive process**, which is **technology-neutral** by default, with (possibly time-limited) exceptions for less mature technologies.
- Support schemes for decarbonising gas should ensure **market participants remain exposed to wholesale price signals** (e.g. by paying support in the

[30] Such as that proposed by Germany for transport and buildings.

form of a fixed premium over market prices), and face full balancing responsibilities.

- Schemes should be **open across EU borders** (and to third countries) from the outset. If this is not politically feasible, a more limited recognition of imported and exported volumes, combined with a gradual opening over time would be an alternative.
- Rules should foresee **an eventual exit from support** once the carbon pricing regime is deemed to ensure sufficient decarbonisation incentives.

Policymakers should **avoid regulated entities making investments in or operating infrastructure which can be developed through such competitive arrangements**. Regulated company involvement in certain types of infrastructure (such as networks) may continue to be relevant, and regulated entities may have roles to play in trialling and piloting new technologies and their integration, where co-ordination barriers arise. Beyond this, operation and/ or ownership of facilities such as PtG plants by a TSO or DSO should only be permitted in limited circumstances, based on a clear rationale (i.e. market failure[31]), under strict conditions, and with a clear exit route.[32]

To underpin both carbon pricing and any market-based support mechanisms, a **scheme to certify the relative GHG emissions content** (or abatement value) **of gases on a consistent basis** should be developed, both for gases produced within and outside the EU. This **could build on existing EU instruments** in place for renewable energy, such as Guarantees of Origin and sustainability certificates (see section 3.2).

The reform of electricity and gas markets, network charges and access arrangements, and taxes and levies should continue, and in particular **ensure** (see section 3.4) **that market participants**:

- **face signals which reflect the whole system impact they have** on the gas and electricity systems; and
- **do not face taxes, tariffs or levies recovering irreversibly sunk costs which distort** unnecessarily the way in which they develop and operate facilities.

Policymakers should **ensure regulatory and institutional arrangements at national and international levels incentivise the optimisation of investments in network infrastructure** across electricity and gas (see section 3.4).

Finally, it will continue to be important for policymakers to **promote research and development in low-carbon gases**: the key will be to strike a delicate balance between ensuring competition between technologies and supporting less mature technologies that could be viable future options. Existing EU-wide institutions (such as the EU ETS' Innovation Fund) could be used for these purposes.

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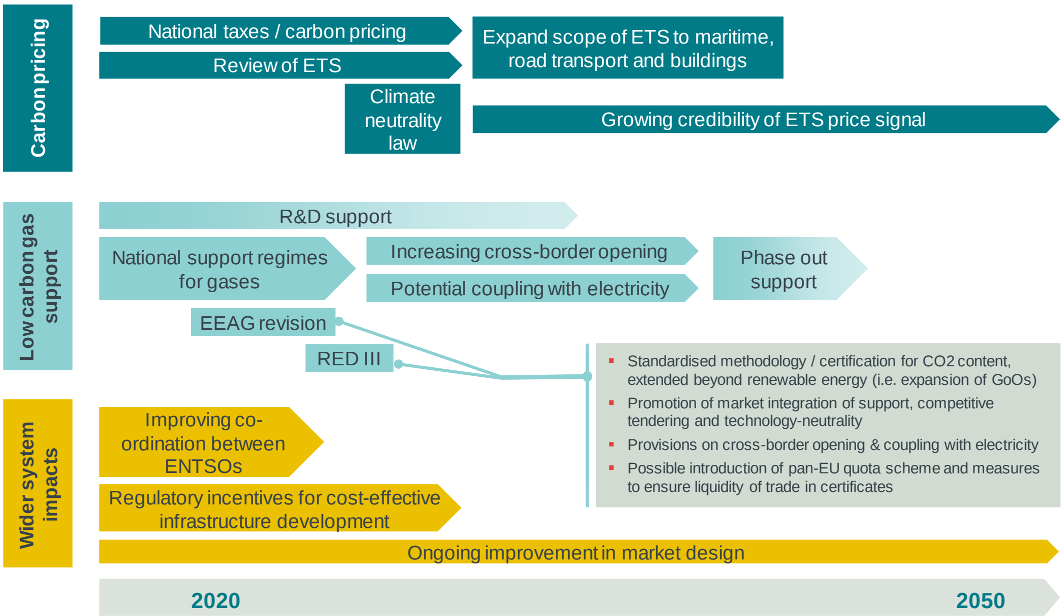
[31] Examples of possible justifications are set out in Frontier Economics et al (2019), p.46-48.

[32] Such an approach would be similar in spirit to existing provisions in the Electricity Directive for electricity grid operator ownership of storage facilities.

Our key recommendations are summarised in the figure below, which illustrates a potential pathway for future reform.

Figure 12 Potential pathway for future reforms to enable gas decarbonisation



Source: Frontier Economics

www.frontier-economics.com